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(54) IMPROVEMENTS IN OR RELATING TO MOULDING OF FOAM

(71) We, THE DUNLOP COMPANY LIMITED, a British Company of Dunlop House, Ryder Street, St. James's, London, S.W.1., formerly of 1, Albany Street, London, N.W.1., do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to pressure differential moulding of foam material.

According to the present invention a method of moulding a porous polyurethane foam material comprises positioning a sheet of porous polyurethane foam material between an air-impermeable elastomeric diaphragm and a heated shaping mould and creating a pressure differential on opposite sides of the diaphragm to cause the diaphragm to move the foam material into forming contact with the heated shaping mould and to at least partially compress the foam.

The invention also includes a moulded foam article when made by the method of the immediately-preceding paragraph.

The pressure differential may be created in a number of ways. For example, a vacuum may be applied between the diaphragm and the mould, thus drawing the foam into contact with the shaping mould. If desired, the pressure differential may be augmented by applying a fluid under pressure to the diaphragm.

Usually, the shaping mould will be heated, for example, by electrical means, to a temperature of between 150°C. and 300°C., preferably 200°C. and 260°C..

Both polyether and polyester polyurethane foams are suitable. The foam which is to be moulded may be in a compressed or uncompressed state and the amount of compression which takes place during the moulding operation will depend on how much compression of the foam took place prior to moulding. The densities of the foams can vary over a wide range but usually the foam before compression has a density of between 1 and 10 lbs/cu.ft and after compression a density of 2 to 75 lbs/cu.ft.

The foam may be a skeletal foam, preferably one obtained by reticulation.

The foam may be a hydrophilic or hydrophobic foam. A hydrophilic foam can be defined in terms of its equilibrium moisture content at various humidities. In a hydrophilic foam, the equilibrium moisture content at 95 per cent relative humidity is at least 2 per cent, preferably 5 per cent greater than the equilibrium moisture content at 60 per cent relative humidity.

The diaphragm can be of any elastomeric material that will not be damaged by the moulding process and is capable of withstanding compression temperatures and may be, for example, a silicone elastomer or elastomers of the type sold as "VITON," (Registered Trade Mark).

When the foam is flock coated, the flocked surface may or may not be in contact with the heated mould. When it is desired to retain the flocked finish, the flocked surface should be remote from the heated shaping mould and, if desired, fluid under pressure applied to the diaphragm in order to create the differential pressure, may be at a temperature such as to keep the diaphragm cool in order to avoid damage and/or permanent set of the flock. The flock coated foam may, if desired, be moulded in an everted shape.

When the flocked surface is in contact with the shaping mould during moulding a felt-like finish is obtained which has good abrasion-resistant properties.

Certain problems arise regarding temperature resistance of the decorative finishes in the aspect where there is no cooling. In particular, where a dyed foam is used

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it is essential that a dyestuff is used which will withstand the moulding temperatures without sublimation or decomposition. Disperse dyes of the metal complex type are suitable.

The invention can be used to obtain products such as:—

(a) Vehicle upholstery. These include moulded seat squabs and backs for cars and commercial vehicles. The moulded covers can be applied separately to the prefabricated cushion base or can form the basis for an integral seat construction where the cushion is foamed directly into the cover.

(b) Domestic and office upholstery.

(c) Footwear upper structures.

(d) Moulded gloves, hats and other wearing apparel.

(e) Soft luggage and handbags.

(f) Soft toys.

The invention is illustrated in the following Examples:—

EXAMPLE I

This Example illustrates a method of forming soft slipper uppers. A 16 mm thick sheet of polyester polyurethane foam having a density of 2 lbs/cu.ft is pre-dyed using a suitable high temperature-resistant dyestuff. A machined aluminium casting mould containing several female cavities is electrically heated to a uniform temperature of 245°C.. A layer of foam is placed flat on the top surface of the mould, followed by a cured silicone rubber diaphragm 0.02 inch thick. A clamping plate is applied to seal the diaphragm against the mould and to trap the foam layer. The air in the cavity between the mould and the diaphragm is extracted through suitably disposed ports in the mould by means of a vacuum pump. The foam is compressed and drawn into intimate contact with the hot mould and allowed to dwell for 10 seconds. The vacuum is then removed, whereupon the diaphragm is released. The moulded foam product is then withdrawn from the mould. The resulting product is a shaped slipper upper having a compressed foam structure of high permeability with a density of 30 lbs/cu.ft. This upper is then soled using any known technique.

EXAMPLE II

This Example illustrates a method of forming simulated animal fur gloves.

An 8 mm layer of reticulated polyester polyurethane foam of density 2.4 lbs/cu.ft is electrostatically flocked with a ten coloured 15 mm 60 denier nylon flock using an acrylate adhesive. The flock is subsequently heat-set flat to the surface of the foam in one direction. This product is loaded into a multi-cavity electrically heated mould having raised half glove impressions, with the flock surface remote from the mould. A Viton diaphragm, 0.075 inch thick, is clamped in position. The Viton diaphragm is an integral part of the lid of the mould which is connected to a pressurised hydraulic fluid supply. The mould is maintained at 220°C.. A hydraulic pressure of 50 lbs/sq.in. is applied to the diaphragm which pressures the foam into contact with the heated mould. The pressure is applied for 20 seconds after which the product is stripped from the mould. The diaphragm which is cooled by the hydraulic fluid maintains the flock finished face at a temperature low enough to prevent heat-setting of the nylon flock. This product forms the back component of the glove.

The palm component of the glove is made as follows.

An 8 mm layer of reticulated polyester foam of density 2.4 lbs/cu.ft is pre-dyed and compressed in a hydraulic diaphragm mould as described above but in this case the foam is moulded for 10 seconds at 240°C. using a hydraulic pressure of 100 lbs/sq.in.. The product is a highly compressed shape having a density of 40 lbs/cu.ft. The two halves of the glove, with the flock finished face of the back inside, are welded together using suitably shaped electrodes to which are applied radio frequency energy of 37 Mc./Sec. After trimming the glove is turned inside out to show the simulated animal fur flock effect on the outer face of the back of the glove.

WHAT WE CLAIM IS:—

1. A method of moulding a porous polyurethane foam material which comprises positioning a sheet of porous polyurethane foam material between an air impermeable elastomeric diaphragm and a heated shaping mould and creating a pressure differential on opposite sides of the diaphragm to cause the diaphragm to move the foam material into forming contact with the heated shaping mould and to at least partially compress the foam.

2. A method of moulding a foam material according to claim 1 in which the pressure differential is created by means of a vacuum applied between the diaphragm and the shaping mould.

3. A method of moulding a foam material according to claim 1 or 2 in which the pressure differential is augmented by means of a fluid under pressure applied to the diaphragm.

4. A method of moulding a foam material according to claim 1, 2 or 3 in which the shaping mould is heated to a temperature of between 150°C and 300°C.

5. A method of moulding a foam mate-

rial according to claim 4 in which the shaping mould is heated to a temperature of between 200°C and 260°C.

6. A method of moulding a foam material according to any preceding claim in which the foam material before compression has a density of between 1 and 10 lbs/cu.ft..

7. A method of moulding a foam material according to any preceding claim in which the foam material after compression has a density of between 2 and 75 lbs/cu.ft.

8. A method of moulding a foam material according to any preceding claim in which the foam material is reticulated.

9. A method of moulding a foam material according to any preceding claim in which the material has a flock-coated surface.

10. A method of moulding a foam material according to claim 9 in which the flock-coated surface is remote from the shaping mould.

11. A method of moulding a foam material according to claim 9 or 10 in which the foam material is moulded in an everted shape.

12. A method of moulding a foam material according to claim 9, 10 or 11 in which the diaphragm is maintained at a temperature such as to avoid damage and/or permanent set of the flock.

13. A method of moulding a foam material substantially as herein described with reference to either Example 1 or 2.

14. A moulded foam article when made by a method according to any preceding claim.

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